Novel Endophyte Varieties: What's the Difference

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Over the past few decades forage producers have seen several major changes in varieties of tall fescue. From the days of Kentucky 31 being the predominant variety, the first change was the development of endophyte-free tall fescue varieties. For many growers, these have been useful additions, especially when coupled with rotational grazing to reduce the risks of overgrazing, and practices that eradicate existing stands of KY-31 and preventing the reintroduction of endophyte infected KY-31. However, these endophyte-free varieties often lacked the persistence of Kentucky 31 and disappointed many early adopters. In the 30 years since the first generation of endophyte-free varieties, plant breeders have made incredible progress in developing additional tall fescue varieties with the latest breakthrough the development and release of novel endophyte varieties.

In 2000, the first commercial sales of a novel endophyte in a tall fescue variety began with Jesup-MaxQ™ (Table 1.). This variety was developed after intensive "proof of concept" research. Researchers had discovered a novel or non-toxic endophyte strain of endophyte (AR542), that when re-infected into the 'Jesup' tall fescue variety, removed all animal toxicity symptoms and allowed the plant to remain persistent (Bouton et al. 2002). Jesup AR542 became Jesup MaxQ™ and was the first novel endophyte product successfully commercialized.

We have now had 15 years of experience to prove the concept that novel endophyte varieties produce no harmful ergot alkaloids (or with BarOptima, low levels) and this provides benefits to producers. Generally, the goal for novel endophyte varieties is to have greater persistence than endophyte-free varieties, but provide animal performance much better than KY-31. The second novel endophyte strain marketed in the USA was from the University of Arkansas and University of Missouri in 'HiMag' tall fescue, and the new variety was originally marketed as ArkPlus. This material is now being sold as Estancia ArkShield™. Barenbrug also tested and released a strain of beneficial endophyte, Plus34, that produces lower levels of ergot alkaloids than the common toxic strain in Kentucky 31, and the current variety with this endophyte is BarOptima PlusE34™. Recently, several new novel endophyte varieties have been released including Texoma MaxQII™ and DuraMax GOLD™. Texoma MaxQII™ has the strain AR584 in it, with greater survival of the endophyte in stored seed and excellent plant benefits. DuraMax Gold™ was developed at Auburn University from Triumph tall fescue and therefore has more winter activity and the novel endophyte strain came from the

University of Arkansas. DLF International is also now marketing the novel varieties Martin 2 Protek™ and Tower Protek™. The University of Kentucky has just released the novel endophyte variety Lacefield MaxQII™. This variety has been extensively testing in Kentucky and we are looking forward to seed being available for KY producers within the next 2-3 years.

Research is continuing on the development of novel endophyte varieties and at a number of seed companies and Universities. In just the last 5 years over 30 experimental varieties have been entered into the UK variety testing program. At the University of Kentucky, progress has been made in engineering the toxic endophyte in Kentucky 31 to be harmless, but this work is still in progress by Dr. Chris Schardl's group in the Department of Plant Pathology. As soon as both functional copies of the ergot alkaloid pathway have been removed or knocked out, the engineered strain will be inserted into elite U.K. tall fescue varieties for evaluation and commercialization.

Adaptation Based on Origin and Test Data

When deciding which novel endophyte variety to plant on your farm there are a number of factors to take into consideration. First of all, carefully review the variety test data from your state or adjacent states. That provides the best indication whether the variety you are interested in is adapted to the conditions on your farm. Another useful indicator of adaptation is where the variety was developed. For example, the variety Texoma MaxQII™ was developed at the Noble Foundation in Ardmore, OK (central Oklahoma). Therefore, you would expect that it is most adapted to farms in Oklahoma, east Texas, Missouri, Arkansas, and Louisiana. Since Lacefield MaxQII™ was developed by the University of Kentucky and extensively tested at research stations in the state, we are confident that it is well adapted in Kentucky.

Yield

One of the most important considerations for any new forage variety is it's forage yield production. Fortunately, the majority of novel endophyte varieties now on the market have shown good yields in Kentucky. Table 1 shows that all of the novel endophyte varieties in this trial at Lexington were statistically in the top grouping (as shown by the "*" beside each variety). Table 2 shows the relative yield of all the novel endophyte varieties that have been in the UK testing program since 2003 and this too supports the assessment that these varieties show good performance in the state. It is important to note, you can have more confidence in the data from varieties that have been in more tests (indicated by the numbers in parentheses).

Table 1. Yield of selected novel endophyte tall fescue varieties *(excerpt from Table 5 of the 2014 Tall Fescue and Bromegrass Report – Olson et al., 2014).*

Variety	Yield (tons/acre) 2012 Total	2013 Total	2014 May 12	2014 Jun 16	2014 Oct 27	2014 Total	3-year Total
Commercial Varieties							
Teton II	3.09	5.32	1.16	0.56	1.56	3.27	11.69*
BarOptima PLUS E34	3.03	5.65	0.93	0.57	1.50	3.00	11.69*
Martin2 647	2.73	5.48	1.08	0.47	1.53	3.09	11.30*
Jesup MaxQ	3.21	5.20	1.02	0.40	1.37	2.79	11.20*
DuraMax GOLD	3.20	4.88	1.11	0.43	1.50	3.03	11.12*
Bronson	3.10	4.98	1.12	0.45	1.42	2.98	11.07*
BarElite	2.81	5.04	1.06	0.53	1.50	3.09	10.94*
Tower 647	3.07	4.93	0.77	0.53	1.43	2.73	10.72*
Jesup EF	2.77	4.97	1.07	0.45	1.43	2.95	10.70*
Cajun II	2.73	4.88	1.12	0.47	1.40	2.98	10.58*
Enhance	2.95	4.75	0.91	0.42	1.12	2.44	10.14
KY31+[3]	2.75	4.80	0.80	0.51	1.27	2.58	10.13
Kentucky 32	2.97	4.62	1.05	0.42	1.05	2.52	10.11
HyMark	2.58	4.66	1.12	0.45	1.16	2.73	9.97
Select	2.70	4.49	0.96	0.41	1.29	2.67	9.85

Table 2. Yield summary of novel endophyte tall fescue varieties from the University of Kentucky forage variety testing program from 2003 through 2015 *(excerpt from Table 4 of the 2015 Long-Term Summary of Kentucky Forage Variety Trials – Olson et al., 2015).*

Variety	Proprietor	03 2-yr	05 3-yr	07 3-yr	09 3-yr	11 3-yr	12 3-yr	13 2-yr	02 3-yr	06 3-yr	08 3-yr	10 3-yr	12 3-yr	13 2-yr	Mean (#trials)
BarOptima PLUS E34[5]	Barenbrug USA	-	122	99	-	107	108	105	-	-	-	99	100	94	104(8)
DuraMax GOLD[5]	DLF International	-	-	-	-	102	-	-	-	106	-	-	-	-	104(2)
Estancia ArkShield[5]	Mountain View Seeds	102	-	-	-	-	106	-	101	-	-	-	102	-	103(4)
Jesup MaxQ[5]	Pennington Seed	-	98	101	110	103	100	97	94	-	95	100	98	102	100(11)
KY31+[5]	KY Agric Exp Sta.	112	108	102	102	93	95	104	104	104	93	112	101	108	103(13)
Lacefield MaxQ II[5]	Pennington Seed	-	-	109	-	-	-	96	-	101	106	-	-	114	105(5)
Martin2 Protek[5]	DLF International	-	-	-	-	104	-	-	-	-	-	-	-	-	104 (1)
Texoma MaxQ II[5]	Pennington Seed	-	95	-	-	-	-	-	-	-	-	-	-	-	95 (1)
Tower Protek[5]	DLF International	-	-	-	-	98	-	-	-	-	-	-	-	-	98 (1)

[5] KY31+ contains the toxic endophyte. Jesup MaxQ, Texoma MaxQ II, Lacefield MaxQ II, DuraMax GOLD, Martin2 647, Tower 647 and Estancia Arkshield contain a contain a non-toxic endophyte. BarOptima PLUS E34 contains a beneficial endophyte. The other fescue varieties in this table do not contain an endophyte.

Persistence

Almost as important as yield is the persistence or survival of novel endophyte varieties. As with yield, the persistence from test locations close to your farm provides the best indication of how well novel endophyte varieties will survive on your farm. Table 3

shows the persistence from a forage variety yield trial in Quicksand, KY (eastern KY) that was planted in the fall of 2013. Fortunately, most of our UK trial data shows good persistence of the currently available novel endophyte varieties in Kentucky. Even more important than survival in yield tests is survival under grazing. Table 4 shows persistence from two of the cool season grass grazing trials that were subjected to continuous grazing as compared to the persistence of KY-31. Note: the far right hand column shows the number of total trials that each variety has been entered in (in parentheses) and the overall persistence average for that variety over years.

Table 3. Persistence of novel endophyte tall fescue varieties *(excerpt from Table 11 of the 2015 Tall Fescue and Bromegrass Report- Olson et al., 2015).*

Variety	Seedling Vigor[1] Oct 3, 2013	Percent Stand 2013 Oct 3	2014 Mar 27	2014 Nov 3	2015 Apr 8	2015 Oct 29
Commercial Varieties-Available for Farm Use						
Lacefield MaxQ II[2]	3.6	100	99	99	99	99
KY31+[2]	3.3	100	100	100	100	100
Select	3.3	100	98	98	98	98
Jesup MaxQ[2]	2.0	100	97	98	99	99
Bull	2.0	100	98	97	97	97
BarOptima PLUS E34[2]	2.3	99	97	97	97	97
Cajun II	1.5	95	78	90	90	92

Table 4. Grazing persistence of novel endophyte tall fescue varieties *(excerpt from Table 4 of the 2015 Long-Term Summary of Kentucky Forage Variety Trials – Olson et al., 2015).*

	Lexington		
Variety	2006 4yr	2007 4yr	Mean
Advance MaxQ	94	--	94 (1)
Bariane	47	29	60 (4)
BarOptima +E34	--	97	99 (5)
Jesup MaxQ	102	97	97 (11)
KY 31+	100	100	100 (14)
Texoma MaxQ	100	98	95 (3)

Maturity

Another factor in determining the novel endophyte variety that is best for your farm is maturity or when the variety produces seedheads. An “early” variety produces

seedheads earlier in the season than other varieties. Part of the maturity rating scale is show below in Table 5. For example, a rating of 45 indicates that the variety was in the "boot" stage when the trial was harvested, and a rating of 50 indicates that a variety was in the early heading stage at harvest (the seedheads had just emerged). Table 6 shows the maturity of a group of tall fescue varieties that were planted in September of 2012 in Lexington, KY. Note: maturity ratings for cool season grasses are not as accurate during the first spring of planting, so the most useful information from this trial is the maturity rating from the spring of 2014 and 2015. The results of this trial show that BarOptima PlusE34 and KY-31 are amongst the latest varieties in the trial in that they were still in the boot stage when the trial was harvested in 2014. Estancia Arkshield and Jesup MaxQ are in the larger group of early maturing varieties in that they were in the heading stage at harvest.

Table 5. Abbreviated maturity scale for cool season grasses.

	Booting
45	Boot swollen
	Inflorescence emergence
50	Upper 1 to 2 cm of inflorescence visible
52	¼ of inflorescence emerged
54	½ of inflorescence emerged
56	¾ of inflorescence emerged
58	Base of inflorescence just visible
	Anthesis
60	Preanthesis
62	Beginning of anthesis

Table 6. Maturity ratings of novel endophyte tall fescue varieties *(excerpt from Table 5 of the 2015 Tall Fescue and Bromegrass Report- Olson et al., 2015).*

	Maturity[2]			
	2013	2014	2015	2012
Variety	**May 20**	**May 9**	**May 11**	**Oct 16**
Commercial Varieties-rm Use				
BarOptima PLUS E34[3]	56.0	45.0	51.0	89.3
Estancia Arkshield[3]	56.0	54.0	57.0	95.8
Jesup EF	58.0	55.5	56.5	95.0
Teton II	58.5	56.5	56.5	93.0
Bull	58.5	57.0	57.5	90.5
Jesup MaxQ[3]	57.5	56.0	56.5	93.5
Select	57.0	55.5	56.0	94.3
Bronson	56.5	56.5	55.5	93.3
Tuscany II	57.0	53.5	56.0	96.5
KY31+[3]	56.0	47.5	52.0	99.0
Cowgirl	57.5	55.5	55.5	95.8
Kentucky 32	58.5	56.0	57.0	92.3

Table 7. Novel endophyte tall fescue commercial products, 2000-2015.

Year of 1st Sales	Cultivar	Tall Fescue Owner	Endophyte Brand	Strain I.D.	U.S. Patent #	Endophyte Owner	Seed Marketer
2000	Jesup	Univ Georgia	MaxQ	AR542	6,111,170	Grasslanz	Pennington Seed
2007	BarOptima	Barenbrug	Plus E34	E34	7,642,424	Barenbrug	Barenbrug USA
2011	Texoma	Noble Foundation	MaxQ II	AR584	6,111,170	Grasslanz	Pennington Seed
2011	Estancia	Univ Missouri	ArkShield	#4	7,465,855 7,553,654 7,977,550	Univ Arkansas	Mountain View Seeds
2011	DuraMax	Auburn Univ	Gold	#9 or #12	7,465,855 7,553,654 7,977,550	Univ Arkansas	DLF International Seeds
2015	Martin2	DLF	Protek	647		DLF	DLF International Seeds
2015	Tower	DLF	Protek	647		DLF	DLF International Seeds

Planting Procedure

When establishing any variety of novel endophyte tall fescue, it is essential that you take the time and effort to properly prepare the field.

One approach is a simple double glyphosate application procedure.

- Spring (entire pasture area):
    - Soil sample; apply lime and fertilizer based on recommendations
    - Remove tall fescue seedheads in the spring via mowing or cutting for hay

- Replaced area
    - Spray with glyphosate 4-6 weeks before planting in mid-summer
    - Re-spray glyphosate at planting (ideally by early September)
    - Plant Novel endophyte variety using no-till seed drill

Another option is using a “spray, smother, spray” approach where the first killing spray is made earlier in the spring, and a summer annual cover crop is used before planting. An additional option is planting a Roundup Ready corn or soybean crop into the field. The limitation with this option is traditional varieties may mature too late for planting during the ideal seeding window. Make sure to choose a short season corn or soybean variety or harvest the crop for silage rather than grain.

In Conclusion

There are many novel endophyte varieties on the market today. From our UK forage variety trials, we are confident that most of these varieties are well adapted to our growing conditions in the Kentucky. There are minor differences in yield, persistence, maturity and grazing tolerance and these should be taken into consideration before purchasing seed.

References

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